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(54) **ELECTRIC WIRE PRINTING DEVICE**

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***B41J 3/407*** (2006.01)
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(58) **Field of Classification Search**
CPC ... H01B 13/345; B41J 11/007; B41J 11/0022; B41J 3/4073
See application file for complete search history.

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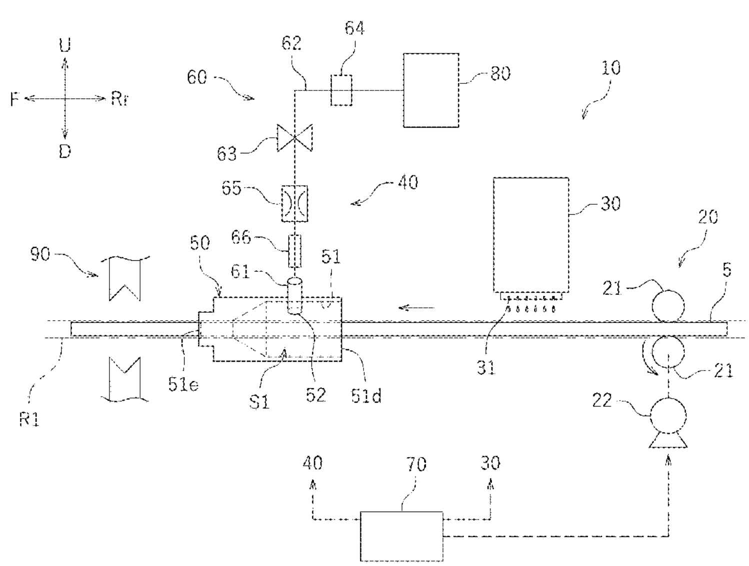
(57) **ABSTRACT**

An electric wire printing device **10** according to the present invention includes an inkjet head **30** injecting ink to perform printing on an electric wire **5**; a transportation device **20** transporting the electric wire **5**; and a drying device **40** provided downstream, in a transportation direction of the electric wire **5**, with respect to the inkjet head **30**, the drying device **40** blowing air toward a printed portion on the electric wire **5**.

**4 Claims, 5 Drawing Sheets**



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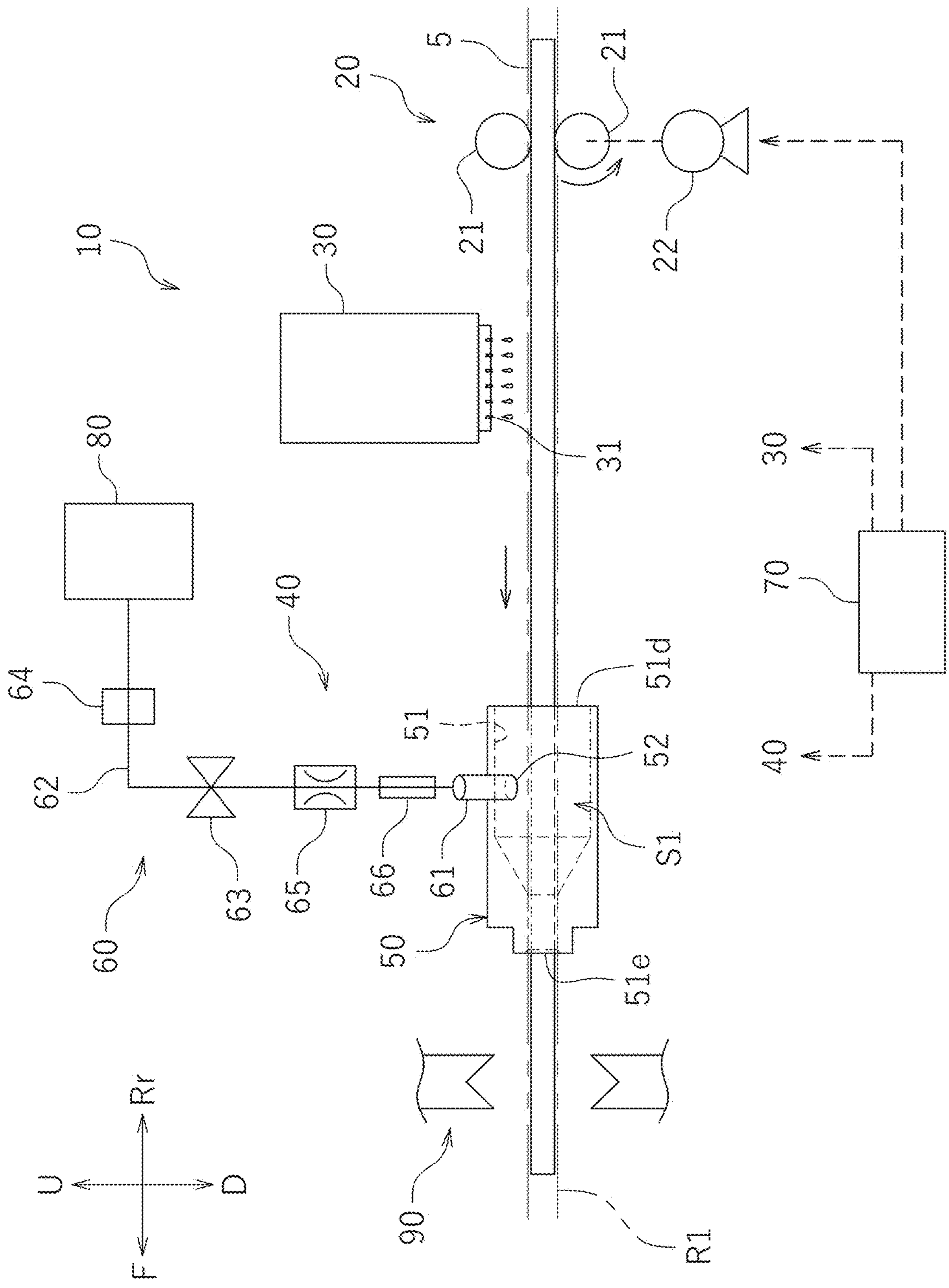
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20
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51d
51
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62
63
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S1
60
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51e
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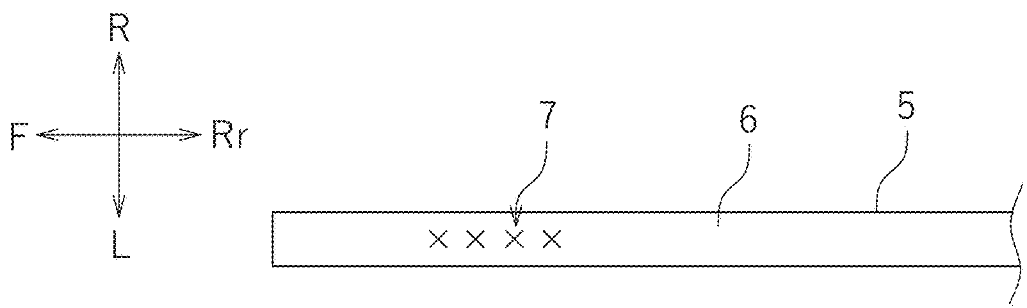
Rr
U
D
F
90
R1

FIG. 1

FIG.2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Rr
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7
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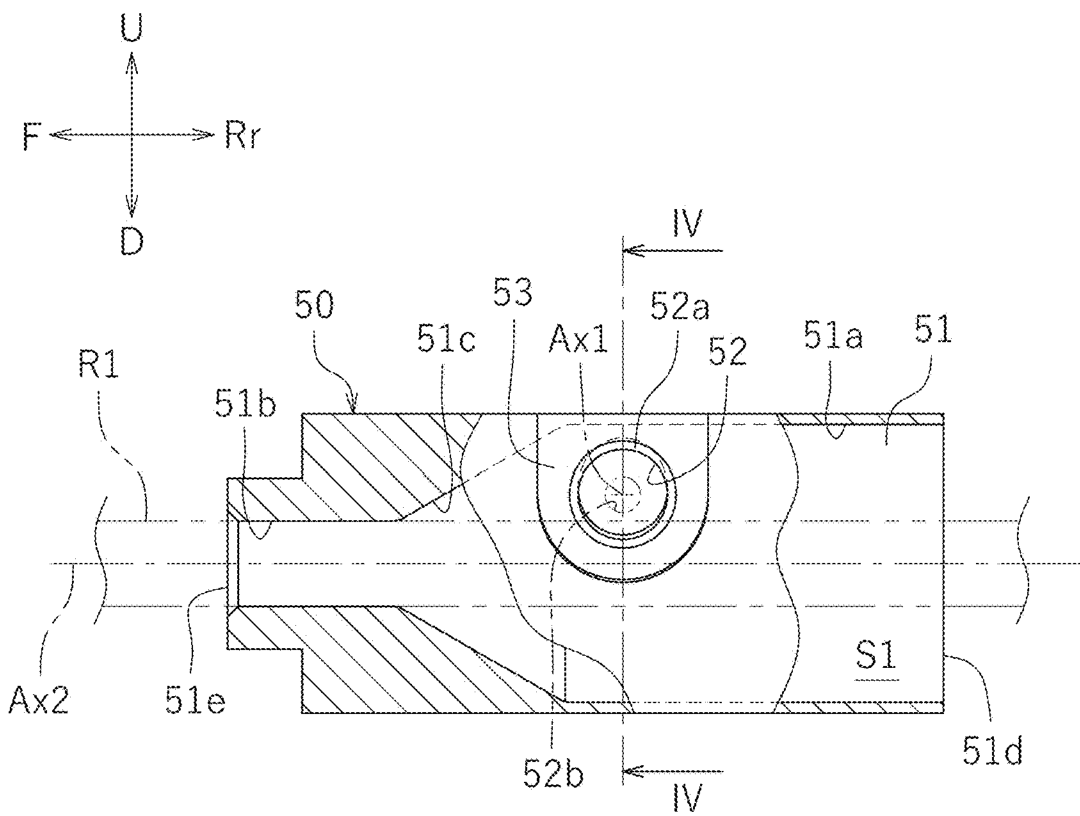
5

FIG.3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51b
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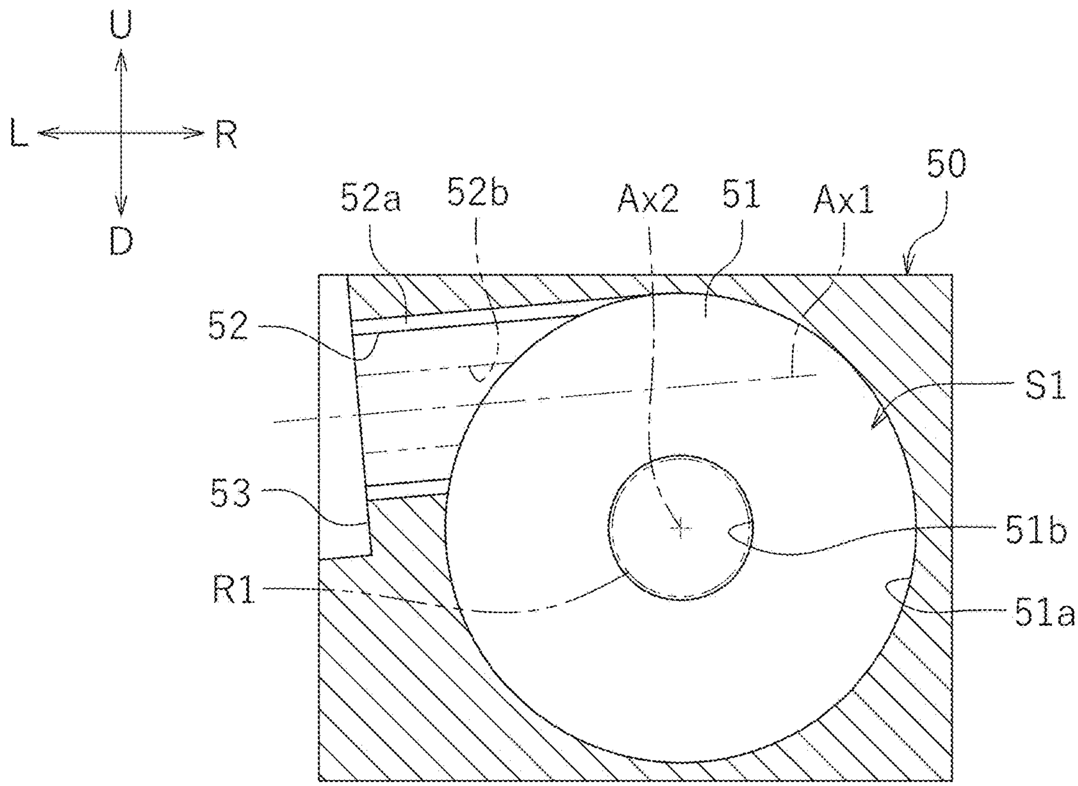
51d
52b
IV

FIG.4


U
L
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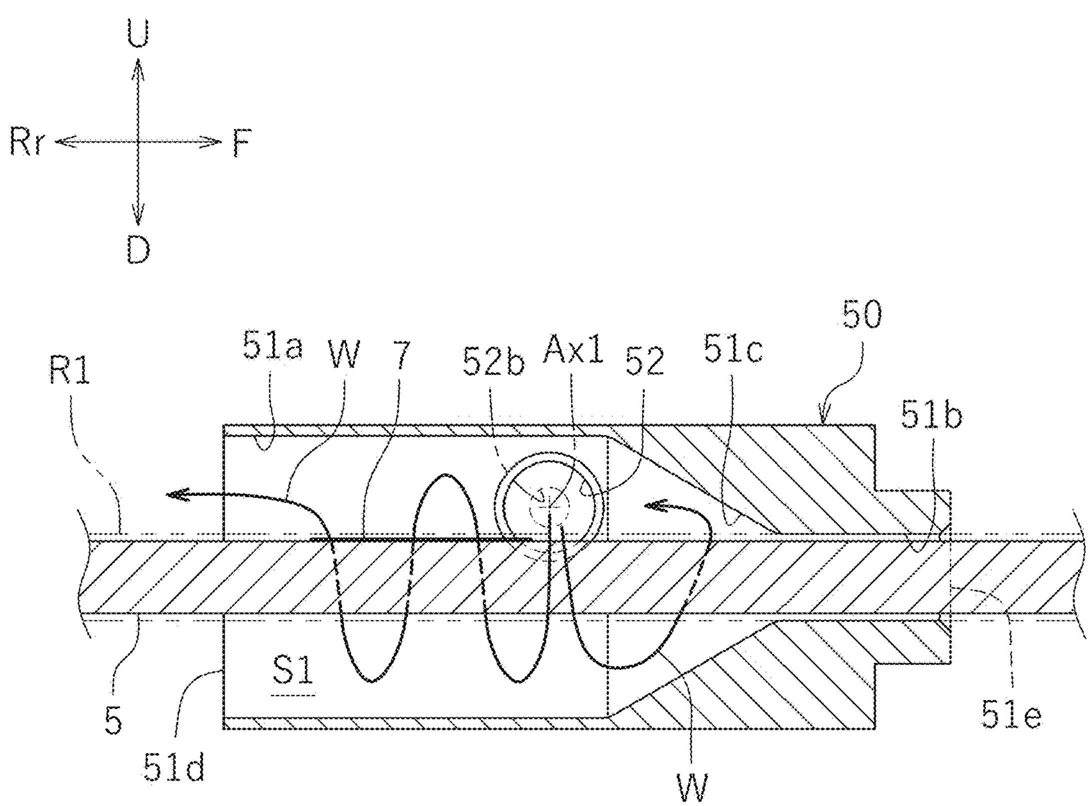
52b
Ax2
51
Ax1
50
52
S1
53
51b
R1
51a

FIG.5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Rr
F
D
R1
51a
W
7
52b
Ax1
52
51c
50
51b
S1
5
51d
W
51e

FIG. 6

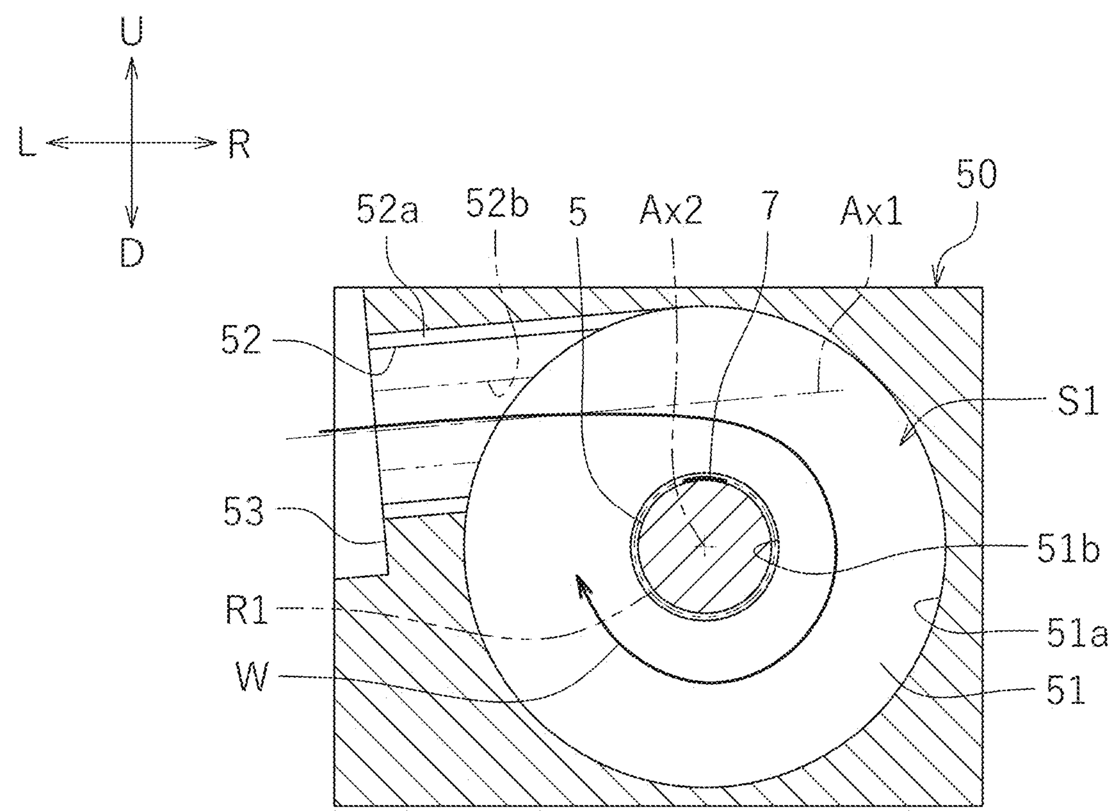
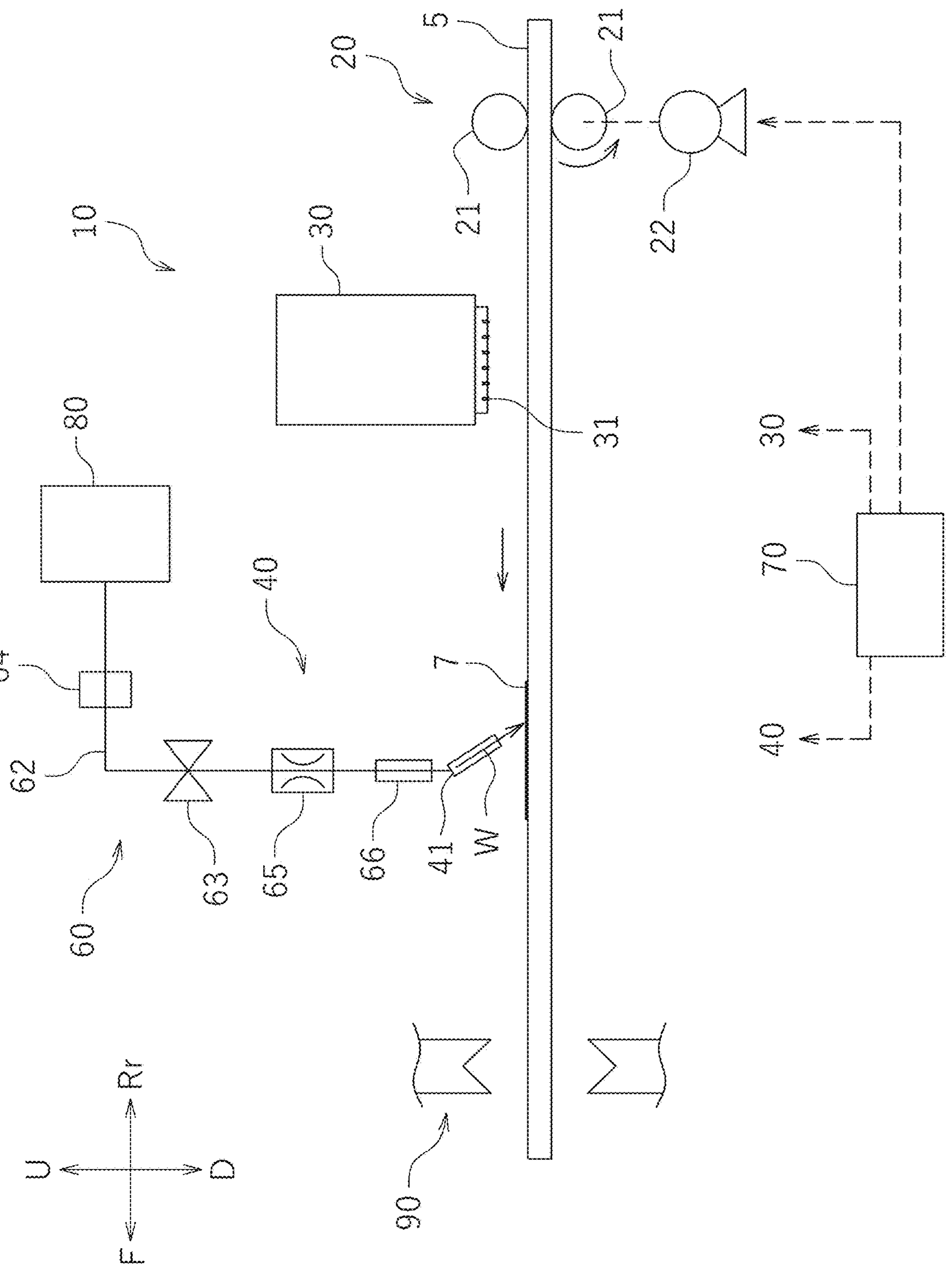


FIG. 7



# ELECTRIC WIRE PRINTING DEVICE

## TECHNICAL FIELD

The present invention relates to an electric wire printing device.

## BACKGROUND ART

Printing on an electric wire has been conventionally performed. For example, Patent Literature 1 discloses a wire harness production method including printing, on an electric wire, circuit information representing to which element the electric wire is to be connected.

## CITATION LIST

### Patent Literature

Patent Literature 1: Japanese Laid-Open Patent Publication No. 2011-181396

## SUMMARY OF INVENTION

### Technical Problem

Printing on an electric wire as described above may be performed by use of an inkjet head that injects ink onto a printing target. However, it requires a certain length of time to dry the ink landed on the electric wire. If the next step is performed before the ink is dried, an inconvenience is likely to occur such that, for example, ink is smudged. For these reasons, production of an electric wire including a step of inkjet printing is time-consuming.

The present invention, made in light of such a point, has an object of providing an electric wire printing device performing printing on an electric wire by an inkjet method and drying ink in a short time.

### Solution to Problem

An electric wire printing device according to the present invention includes an inkjet head injecting ink to perform printing on an electric wire; a transportation device transporting the electric wire; and a drying device provided downstream, in a transportation direction of the electric wire, with respect to the inkjet head, the drying device blowing air toward a printed portion on the electric wire.

According to the above-described electric wire printing device, the air blown toward the printed portion on the electric wire by the drying device promotes the drying of the ink of the printed portion. Therefore, the ink is dried in a short time.

According to a preferred embodiment of the present invention, the transportation device transports the electric wire while the drying device is blowing the air toward the printed portion on the electric wire. The drying device blows the air upstream in the transportation direction of the electric wire.

According to this embodiment, the transportation direction, in which the electric wire is transported by the transportation device, and the direction in which the air flows are opposite to each other. Therefore, the flow of the air flows at a speed, with respect to the electric wire, that is a sum of a transportation speed of the electric wire and a speed of the air. As a result, the drying of the ink is further promoted.

According to a preferred embodiment of the present invention, the transportation device transports the electric wire in a longitudinal direction of the electric wire. The drying device includes a tubular member provided so as to surround a transportation path of the electric wire. An inner space through which the electric wire is to pass is demarcated in the tubular member. The tubular member includes a supply inlet opened toward the inner space, the supply inlet allowing compressed air to be supplied therethrough, and an opening allowing the inner space and a space outside the tubular member to communicate with each other such that the compressed air is discharged from the inner space.

According to this embodiment, the printed portion of the electric wire is surrounded by the tubular member. Therefore, the compressed air supplied into the tubular member is not easily diffused. This improves the efficiency at which the ink is dried. Therefore, the ink is dried in a shorter time.

According to a preferred embodiment of the above-described embodiments, the transportation device transports the electric wire while the compressed air is supplied from the supply inlet. The opening is provided upstream, in the transportation direction of the electric wire, with respect to the supply inlet.

According to this embodiment, the transportation direction, in which the electric wire is transported by the transportation device, and the direction in which the compressed air flows are opposite to each other. Therefore, the drying of the ink is further promoted for the above-described reason.

According to a preferred embodiment of the above-described embodiments, the opening is provided at an upstream end, in the transportation direction of the electric wire, of the tubular member. The transportation device inserts the electric wire into the inner space of the tubular member from the opening.

According to this embodiment, one opening is usable both as an entrance for the electric wire into the tubular member and an exit for the compressed air from the tubular member. This simplifies the configuration of the tubular member.

According to a preferred embodiment of the embodiments in which the electric wire printing device includes the tubular member, the tubular member includes an electric wire exit allowing the electric wire to pass therethrough, the electric wire exit being provided at a downstream end, in the transportation direction of the electric wire, of the tubular member. The electric wire exit has an opening area that is smaller than an opening area of the opening.

According to this embodiment, the opening area of the electric wire exit is smaller than the opening area of the opening. Therefore, the compressed air easily flows toward the opening.

According to a preferred embodiment of the embodiments in which the electric wire printing device includes the tubular member, the supply inlet runs through the tubular member in a direction crossing the longitudinal direction of the electric wire.

According to this embodiment, the compressed air easily circles around the electric wire. In the case where the compressed air easily circles around the electric wire, the ink is dried regardless of the direction of the printed portion. Even in the case where the printed portion is not directed as being set for a reason that, for example, the electric wire is twisted in a circumferential direction thereof, the ink is dried.

According to a preferred embodiment of the above-described embodiments, the supply inlet is provided so as to be shifted with respect to the transportation path of the electric wire as seen in a direction in which the supply inlet runs through the tubular member.

According to this embodiment, the supply inlet and the transportation path of the electric wire are shifted with respect to each other, so that the compressed air supplied from the supply inlet is prevented from directly hitting the printed portion. Therefore, decline in the printing quality, which is caused by the compressed air being jetted directly toward the ink in a non-dried state, is suppressed.

## Advantageous Effects of Invention

An electric wire printing device according to the present invention dries ink injected onto an electric wire in a short time.

## BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic view showing a configuration of an electric wire printing device according to an embodiment.

FIG. **2** is a schematic plan view showing an example of electric wire in a post-printing state.

FIG. **3** is a partial cross-sectional view of a guide pipe as seen in a side view.

FIG. **4** is a cross-sectional view of the guide pipe passing through an air supply inlet, taken along a radial direction thereof.

FIG. **5** is a cross-sectional view of the guide pipe as seen in a side view, schematically showing a flow of compressed air.

FIG. **6** is a cross-sectional view of the guide pipe as seen in a rear view, schematically showing the flow of the compressed air.

FIG. **7** is a schematic view showing a configuration of an electric wire printing device according to another embodiment.

## DESCRIPTION OF EMBODIMENTS

[Configuration of the Printing Device]

FIG. **1** is a schematic view showing a configuration of an electric wire printing device **10** (hereinafter, referred to as the "printing device **10**") according to an embodiment of the present invention. In the following description, referring to FIG. **1**, the left side, the right side, the up side, the down side, the side closer to the viewer of FIG. **1**, and the side farther from the viewer of FIG. **1** will be respectively defined as the front side, the rear side, the up side, the down side, the left side and the right side with respect to the printing device **10**. In the drawings, letters F, Rr, L, R, U and D respectively represent front, rear, left, right, up and down with respect to the printing device **10**. Note that these directions are merely defined for the sake of description, and do not limit the present invention in any way.

As shown in FIG. **1**, the printing device **10** according to this embodiment includes a transportation device **20** transporting an electric wire **5**, an inkjet head **30** performing printing on the electric wire **5**, a drying device **40** drying ink landed on the electric wire **5**, and a controller **70**. A clamp **90** holding the electric wire **5** in a post-printing state and a cutting device (not shown) for the electric wire **5** are provided to the front of the printing device **10**.

The transportation device **20** transports the electric wire **5** in a longitudinal direction of the electric wire **5**. In this embodiment, the front side is a downstream side in a transportation direction of the electric wire **5**. The rear side is an upstream side in the transportation direction of the electric wire **5**. Note that the transportation direction of the electric wire **5** is not limited to the front-rear direction. In the following, the upstream side in the transportation direction of the electric wire **5** and the downstream side in the transportation direction of the electric wire **5** may also be simply referred to as the "upstream" and the "downstream" when appropriate. As shown in FIG. **1**, the transportation device **20** includes a pair of transportation rollers **21** and a transportation motor **22** rotating the pair of transportation rollers **21**. The pair of transportation rollers **21** face each other. The electric wire **5** is held between the pair of transportation rollers **21**. One of the pair of transportation rollers **21** rotates in this state, and as a result, the electric wire **5** is transported in the longitudinal direction thereof.

The inkjet head **30** is provided downstream with respect to the transportation device **20**. The transportation device **20** transports the electric wire **5** in a pre-printing state to the inkjet head **30**. The inkjet head **30** injects ink to perform printing on the electric wire **5**. FIG. **2** is a schematic plan view showing an example of the electric wire **5** in the post-printing state. As shown in FIG. **2**, the inkjet head **30** forms a printed image **7**, with the injected ink, on a sheath **6** provided as an outermost element of the electric wire **5**. The sheath **6** is an insulating sheath covering a core of the electric wire **5**, and is formed of, for example, a resin. The printed image **7** includes, for example, letters, symbols, graphical patterns and the like representing information such as specifications, uses, an orientation, a model number and the like of the electric wire **5**. Note that the image to be printed on the electric wire **5** is not limited to the above. There is no specific limitation on the color of the printed image **7**. The printed image **7** may have a plurality of colors.

The inkjet head **30** includes a great number of nozzles **31** injecting ink downward. Such a plurality of nozzles **31** are provided in a bottom surface of the inkjet head **30**. The plurality of nozzles **31** are located above a transportation path R1, along which the electric wire **5** is to be transported by the transportation device **20**. In this embodiment, the ink to be injected from the nozzles **31** of the inkjet head **30** is solvent ink containing a dye or a pigment dissolved in a solvent. The solvent ink is solidified by the solvent being volatilized. There is no specific limitation on the type of ink to be injected from the inkjet head **30** as long as the ink is solidified by the solvent being volatilized. The ink may be, for example, aqueous ink containing water as the solvent. The solvent is naturally volatilized, and therefore, the ink may be naturally dried. However, it requires a certain length of time to naturally dry the ink.

The drying device **40** is provided downstream, in the transportation direction of the electric wire **5**, with respect to the inkjet head **30**. The transportation device **20** transports the electric wire **5**, after the inkjet head **30** performs printing on the electric wire **5**, from below the inkjet head **30** to the drying device **40**. The drying device **40** blows air toward a printed portion on the electric wire **5** to dry the ink on the electric wire **5**. Note that the drying device **40** may blow gas other than the air toward the printed portion on the electric wire **5**. The drying device **40** rapidly volatilizes the solvent in the ink to solidify the ink in a short time. As shown in FIG. **1**, the drying device **40** includes a tubular guide pipe **50** provided so as to surround the transportation path R1 of the electric wire **5** and an air supply **60** supplying compressed air to the guide pipe **50**. In the guide pipe **50**, an inner space S1, through which the electric wire **5** is to pass, is demarcated. In this embodiment, the guide pipe **50** includes an insertion hole **51**, through which the electric wire **5** is to be inserted. A space inner in a radial direction of the insertion hole **51** forms the inner space S**1**. The transportation device **20** transports the electric wire **5** such that the electric wire **5** passes through the insertion hole **51**.

FIG. **3** is a partial cross-sectional view of the guide pipe **50** as seen in a side view. FIG. **4** is a cross-sectional view taken along line IV-IV of FIG. **3**. FIG. **4** shows a cross-section of the guide pipe **50** taken along a plane extending in the left-right direction and the up-down direction. As shown in FIG. **3** and FIG. **4**, the guide pipe **50** includes the insertion hole **51** forming the inner space S**1**, an air supply inlet **52** opened toward the inner space S**1**, and a joint seating surface **53** for an air joint **61** (see FIG. **1**) to be connected with the air supply inlet **52**. The air supply inlet **52** is a hole through which the compressed air, formed by an air compressor **80** (see FIG. **1**) external to the printing device **10**, is to be supplied.

The insertion hole **51** runs through the guide pipe **50** in the front-rear direction. As shown in FIG. **3**, the insertion hole **51** includes a long diameter portion **51***a*, a short diameter portion **51***b*, a tapering portion **51***c*, an entrance opening **51***d*, and an electric wire exit **51***e*. The long diameter portion **51***a* forms an upstream portion of the insertion hole **51**. As shown in FIG. **4**, the long diameter portion **51***a* has a tubular shape. As shown in FIG. **3**, the long diameter portion **51***a* has a diameter longer than a diameter of the electric wire **5** (see the transportation path R**1** of the electric wire **5**). In this embodiment, the diameter of the long diameter portion **51***a* is longer than 1.5 times the diameter of the electric wire **5**. In a state where the electric wire **5** is inserted into the insertion hole **51**, a tubular space is formed between an inner wall of the long diameter portion **51***a* and the electric wire **5**.

The entrance opening **51***d* is opened so as to allow the inner space S**1** and a space outside the guide pipe **50** to communicate with each other. In this embodiment, the entrance opening **51***d* is provided at an upstream end of the guide pipe **50**. The entrance opening **51***d* is an upstream end of the long diameter portion **51***a*. The transportation device **20** inserts the electric wire **5** from the entrance opening **51***d* into the inner space S**1** of the guide pipe **50**. As described below in more detail, the entrance opening **51***d* is also an air discharge opening through which the compressed air supplied from the air supply inlet **52** is to be discharged from the inner space S**1**.

The short diameter portion **51***b* forms a downstream portion of the insertion hole **51**. As shown in FIG. **4**, the short diameter portion **51***b* also has a tubular shape. The short diameter portion **51***b* is concentric with the long diameter portion **51***a* as seen in the front-rear direction. The short diameter portion **51***b* has a diameter shorter than the diameter of the long diameter portion **51***a* and substantially equal to the diameter of the electric wire **5**. The diameter of the short diameter portion **51***b* is slightly longer than the diameter of the electric wire **5**, such that the electric wire **5** passes through the short diameter portion **51***b*. The tapering portion **51***c* is formed between the long diameter portion **51***a* and the short diameter portion **51***b*. The tapering portion **51***c* has a tapering shape which has a diameter decreasing toward the downstream side in the transportation direction of the electric wire **5**.

The electric wire exit **51***e* is provided at a downstream end of the guide pipe **50**. The electric wire exit **51***e* is an exit for the electric wire **5** and allows the electric wire **5** to pass therethrough. In this embodiment, the electric wire exit **51***e* is a downstream end of the short diameter portion **51***b*. The electric wire exit **51***e* has an opening area smaller than an opening area of the entrance opening **51***d*.

As shown in FIG. **3**, the air supply inlet **52** is opened toward a side surface of the guide pipe **50**. As shown in FIG. **4**, the air supply inlet **52** runs through the guide pipe **50** in a direction crossing the longitudinal direction of the electric wire **5** (in this embodiment, the longitudinal direction of the electric wire **5** is the front-rear direction). In this embodiment, the air supply inlet **52** runs through the guide pipe **50** in a direction oblique to the left-right direction so as to perpendicularly cross the front-rear direction, which is the transportation direction of the electric wire **5**, and reaches the inner wall of the long diameter portion **51***a*. Such a positional arrangement of the air supply inlet **52** allows the entrance opening **51***d* to be located upstream, in the transportation direction of the electric wire **5**, with respect to the air supply inlet **52**. Such a positional arrangement of the air supply inlet **52** allows the electric wire exit **51***e* to be located downstream, in the transportation direction of the electric wire **5**, with respect to the air supply inlet **52**.

An inner wall of the air supply inlet **52** has a screw **52***a* formed therein. The air joint **61** includes a screw portion engageable with the screw **52***a*, and thus is connected with the air supply inlet **52**. The joint seating surface **53** is formed around an outer end of the air supply inlet **52** (end exposed to an outer surface of the guide pipe **50**), such that the joint seating surface **53** perpendicularly crosses an axis Ax**1** of the air supply inlet **52**.

As shown in FIG. **3**, the air supply inlet **52** (in this embodiment, a substantial air supply inlet **52**, that is, a flow path, in the air joint **61**, represented by reference sign **52***b*; see also FIG. **4**) is provided so as to be shifted with respect to the transportation path R**1** of the electric wire **5** as seen in the direction in which the air supply inlet **52** runs through the guide pipe **50**). The axis Ax**1** of the air supply inlet **52** is shifted so as not to cross an axis Ax**2** of the insertion hole **51** (the axis Ax**2** is also the central line of the transportation path R**1** of the electric wire **5**).

The air supply **60** controls the supply of the compressed air into the air supply inlet **52**. The compressed air is generated by the air compressor **80** external to the printing device **10**. Note that the printing device **10** may include a device generating the compressed air like an air compressor. As shown in FIG. **1**, the air supply **60** includes the air joint **61**, an air flow path **62**, an open/close valve **63**, a decompression valve **64**, a flow rate adjusting valve **65**, and a heater **66**.

The air joint **61** is in engagement with the screw **52***a* of the air supply inlet **52**. The air joint **61** is in contact with the joint seating surface **53**. The air flow path **62** connects the air compressor **80** and the air joint **61** to each other. In this embodiment, the air flow path **62** is a flexible tube. One of ends of the air flow path **62** is connected with the air joint **61**, and the other end of the air flow path **62** is connected with the air compressor **80**.

The open/close valve **63**, the decompression valve **64** and the flow rate adjusting valve **65** are provided on the air flow path **62**. The open/close valve **63** closes or opens the air flow path **62**. The open/close valve **63** is, for example, an electromagnetic valve. The open/close valve **63** is connected with the controller **70**, and is controlled by the controller **70**. The open/close valve **63** opens or closes the air flow path **62** under the control of the controller **70**, and as a result, the compressed air is supplied to the drying device **40** or the supply of the compressed air to the drying device **40** is stopped. The decompression valve **64** decreases the pressure of the compressed air generated by the air compressor **80** down to a pressure suitable for use in the drying device **40**.

The flow rate adjusting valve **65** adjusts the flow rate of the compressed air to a flow rate suitable for use in the drying device **40**.

The heater **66** heats the compressed air in the air flow path **62**. In this embodiment, the heater **66** is a tape-like heater wound around the air flow path **62**. The heater **66** heats the air flow path **62** and thus heats the compressed air in the air flow path **62**. The heating by the heater **66** allows the drying device **40** to blow warm air having a temperature higher than room temperature (temperature around the drying device **40**) toward the electric wire **5** in the drying device **40**. The temperature of the heater **66** may be controlled by the controller **70**. Alternatively, the controller **70** may only control the heater **66** to be activated or to be stopped, whereas the heater **66** may control the temperature thereof.

The above-described configuration of the air supply **60** is a preferred example, and the configuration of the air supply **60** is not limited to this. The air flow path **62** is not limited to being a tube, and may be, for example, a non-flexible pipe. The open/close valve **63** is not limited to an electromagnetic valve, and may be, for example, a motor-drivable valve. The heater **66** is not limited to a sheet-like heater that can be wound around, and may be, for example, a hot air generator that heats the air passing therein. The heater **66** may heat the guide pipe **50**. The drying device **40** does not need to include the heater **66**. The drying device **40** does not need to include the open/close valve **63**, the decompression valve **64** or the flow rate adjusting valve **65**.

The controller **70** is connected with the transportation device **20**, the inkjet head **30** and the drying device **40**, and controls operations of these elements. There is no specific limitation on the configuration of the controller **70**. The controller **70** may include, for example, a central processing unit (CPU), a ROM storing, for example, a program to be executed by the CPU, a RAM and the like. Processing portions of the controller **70** may be formed of software or hardware. The processing portions may each be a processor or a circuit. The controller **70** may be, for example, a programmable controller, a computer or the like. The controller **70** may be a computer exclusively usable for the printing device **10**, or a general-purpose computer such as a personal computer or the like. The controller **70** may be a computer on the cloud.

[Printing Process]

Hereinafter, an example of process of performing printing on the electric wire **5** by the printing device **10** will be described. Note that the printing process described below is merely a preferred example, and the printing process on the electric wire **5** is not limited to the one described below. Such a preferred example of the printing process on the electric wire **5** is as follows. In an initial step, the electric wire **5** is transported by the transportation device **20** to a position below the inkjet head **30**. The inkjet head **30** is driven while the electric wire **5** is passing below the inkjet head **30** and prints the predetermined image **7** on the sheath **6** of the electric wire **5** that is being transported. At this point, the ink of the printed image **7** is not dried yet, and may be smudged or erased if, for example, being touched by another item.

In this embodiment, at the same time as, or substantially at the same time as, the start of the transportation of the electric wire **5**, the air supply **60** starts supplying the compressed air to the guide pipe **50**. Note that there is no specific limitation on the timing when the supply of the compressed air to the guide pipe **50** is started.

When the injection of the ink onto the electric wire **5** is completed, the electric wire **5** is inserted into the insertion hole **51** of the guide pipe **50** by the transportation device **20**. The transportation device **20** inserts the electric wire **5** into the guide pipe **50** from the entrance opening **51***d*. The transportation device **20** continues transporting the electric wire **5**. As a result, a front end portion of the electric wire **5** is inserted into the short diameter portion **51***b* of the insertion hole **51**. The electric wire **5** is not always linear and may be slightly curved or bent. Even in such a case, the electric wire **5** is guided into the short diameter portion **51***b* by the tapering portion **51***c*. The electric wire **5** may be twisted in a circumferential direction thereof. In such a case, the printed image **7** may not be directed upward.

Then, the front end portion of the electric wire **5** exits the guide pipe **50** from the electric wire exit **51***e*. A portion of the electric wire **5** that is outside the guide pipe **50** passes through a space inner to claws of the clamp **90**. At this point, the ink of the printed image **7** has already been dried and the ink has been solidified. Therefore, the printed image **7** is not smudged or erased even if being touched by the clamp **90**. When the electric wire **5** is inserted, by a predetermined length, into the cutting device (not shown) provided downstream, in the transportation direction, with respect to the clamp **90**, the transportation of the electric wire **5** is stopped. The electric wire **5** is held by the clamp **90** at this position, and is cut into a predetermined length by the cutting device. After this, in a state where the electric wire **5** is already inserted into the guide pipe **50**, the printing of the image **7**, the drying, and the cutting of the electric wire **5** are repeated in the same manner as described above.

Hereinafter, the state inside the guide pipe **50** having the electric wire **5** inserted thereto will be described. FIG. **5** is a cross-sectional view of the guide pipe **50** as seen in a side view, and schematically shows the flow of the compressed air. FIG. **6** is a cross-sectional view of the guide pipe **50** as seen in a rear view, and schematically shows the flow of the compressed air. In FIG. **5** and FIG. **6**, arrow W represents the flow of the compressed air. As shown in FIG. **6**, the compressed air, flowing from the air supply inlet **52** into the inner space S**1** of the guide pipe **50**, flows so as to circle around the transportation path R**1** of the electric wire **5** as seen in the front-rear direction. In this embodiment, the air supply inlet **52** (here, the substantial air supply inlet **52***b*) is provided such that an extended portion of the axis Ax**1** thereof does not cross the transportation path R**1** of the electric wire **5**. Therefore, the compressed air flowing from the air supply inlet **52** into the inner space S**1** easily flows so as to circle around the transportation path R**1** of the electric wire **5**. The compressed air flowing from the air supply inlet **52** into the inner space S**1** is not directly blown toward the electric wire **5**, in particular, toward the printed image **7**.

As shown in FIG. **5**, after the electric wire **5** is inserted into the short diameter portion **51***b* of the insertion hole **51**, the electric wire exit **51***e* is almost closed by the electric wire **5**. Therefore, an exit through which the flow W of the compressed air can go out of the guide pipe **50** is almost limited to the entrance opening **51***d*. As a result, the compressed air flows upstream in the transportation direction of the electric wire **5**. As shown in FIG. **5**, the compressed air flows upstream in the transportation direction of the electric wire **5** while spirally circling around the electric wire **5**. The opening area of the entrance opening **51***d* is at least larger than the opening area of the electric wire exit **51***e*, and thus, is larger than a cross-sectional area of the electric wire **5**. Therefore, the entrance opening **51***d* is not closed by the electric wire **5**. As a result, the flow W of the compressed air directed upstream in the transportation direction of the electric wire **5** is generated.

The flow W of the compressed air directed upstream in the transportation direction of the electric wire **5** while spirally circling around the electric wire **5** acts advantageously to dry the ink of the printed image **7**. First, the guide pipe **50** is formed to have a tubular shape surrounding the transportation path R**1** of the electric wire **5**, and therefore, the compressed air supplied into the guide pipe **50** is not easily diffused. This allows the ink to be dried in a shorter time than in the case where, for example, the compressed air is blown toward the printed image **7** in a free space. This also saves the amount of the compressed air to be used. In addition, the guide pipe **50** is tubular, and therefore, the compressed air supplied from the air supply inlet **52** swirls in the inner space S**1** of the guide pipe **50**. This allows the swirling compressed air to be blown toward the printed image **7** even in the case where the printed image **7** is not directed as being set for a reason that, for example, the electric wire **5** is twisted in the circumferential direction thereof. The drying device **40** according to this embodiment allows the ink of the printed image **7** to be dried even in the case where the printed image **7** is not directed as being set (more broadly, regardless of the direction of the printed image **7**).

In this embodiment, the air supply inlet **52** runs through the guide pipe **50** in a direction crossing the longitudinal direction of the electric wire **5**. This makes it easier for the compressed air to circle around the electric wire **5**. In addition, in this embodiment, the air supply inlet **52** (here, the substantial air supply inlet **52***b*) is provided so as to be shifted with respect to the transportation path R**1** of the electric wire **5** as seen in a direction in which the air supply inlet **52** runs through the guide pipe **50**. This also promotes the circling flow of the compressed air around the electric wire **5**. In addition, this prevents the compressed air, flowing from the air supply inlet **52**, from directly hitting the printed image **7**. If the compressed air is directly jetted toward the ink of the printed image **7** in a state where the ink is not dried, the ink may be blown away or moved to undesirably decline the quality of the printed image **7**. The drying device **40** according to this embodiment reduces such an undesirable possibility.

In this embodiment, the flow W of the compressed air in the guide pipe **50** is directed upstream in the transportation direction. Such a direction of the flow is opposite to the transportation direction, in which the electric wire **5** is transported by the transportation device **20**. The transportation device **20** transports the electric wire **5** downstream in a state where the compressed air is supplied from the air supply inlet **52** into the inner space S**1**. Therefore, the flow W of the compressed air flows at a speed, with respect to the electric wire **5**, that is a sum of a transportation speed of the electric wire **5** and a speed of the compressed air. As a result, the speed of the flow W of the compressed air with respect to the electric wire **5** is increased, and thus the drying of the ink of the printed image **7** is further promoted. Such a flow of the compressed air is generated by the entrance opening **51***d* being provided upstream, in the transportation direction of the electric wire **5**, with respect to the air supply inlet **52**. In this embodiment, the entrance opening **51***d* is provided at the upstream end of the guide pipe **50**, and acts both as an entrance for the electric wire **5** into the guide pipe **50** and an exit for the compressed air from the guide pipe **50**. This simplifies the configuration of the guide pipe **50**.

In addition, in this embodiment, the opening area of the electric wire exit **51***e* is smaller than the opening area of the entrance opening **51***d*. This causes the compressed air in the guide pipe **50** to be more easily directed upstream in the transportation direction of the electric wire **5**. In this embodiment, the opening area of the electric wire exit **51***e* is substantially the same as the cross-sectional area of the electric wire **5**. Therefore, in a state where the electric wire **5** passes through the electric wire exit **51***e*, the electric wire exit **51***e* is almost closed by the electric wire **5**. As a result, the compressed air in the guide pipe **50** flows upstream in the transportation direction of the electric wire **5**.

The present inventors have confirmed by a simulation that the compressed air flows upstream in the transportation direction of the electric wire **5** while spirally circling around the electric wire **5** (flows as shown in FIG. **5** and FIG. **6**). The present inventors have also confirmed that the use of the printing device **10** according to this embodiment allows the ink of the printed image **7** to be dried in a much shorter time than natural drying. The temperature of the compressed air contributes to decrease in the time for drying the printed image **7**. However, the compressed air may or may not be heated because it is difficult to maintain the temperature of the air flowing in the air supply path **62** while being replaced continuously. According to tests performed by the present inventors, the ink of the printed image **7** is dried in a short time even if the temperature of the compressed air is room temperature. Note that use of, for example, a hot air generator or the like stably maintains the temperature of the air to be supplied to the air supply inlet **52**.

## OTHER EMBODIMENTS

A preferred embodiment is described above. The above-described embodiment is merely an example, and various other embodiments may be carried out. For example, in the above-described embodiment, the compressed air is blown toward the ink of the printed image **7** while the electric wire **5** is moved. The compressed air may be blown while the electric wire **5** is stopped. In the above-described embodiment, the entrance opening **51***d*, through which the compressed air exits, is opened upstream in the transportation direction of the electric wire **5**. The entrance opening **51***d* may be opened downstream in the transportation direction of the electric wire or in any other direction. The opening through which the compressed air exits does not need to be the entrance opening, through which the electric wire is to be inserted.

In the above-described embodiment, the guide pipe **50** includes the electric wire exit **51***e*. The guide pipe **50** does not need to include the electric wire exit **51***e*. In this case, the electric wire may be returned upstream in the transportation direction after the ink is dried. The transportation direction of the electric wire is not limited to the longitudinal direction of the electric wire. The electric wire may be, for example, translated in a direction crossing the longitudinal direction thereof or may circle around.

There is no specific limitation on the configuration of a tubular member, an example of which is the guide pipe **50**. It is sufficient that the tubular member is provided so as to surround the transportation path of the electric wire, and includes an air supply inlet through which the compressed air is to be supplied and also includes an opening opened so as to allow the compressed air to be discharged. There is no further limitation on the tubular member. For example, the air supply inlet may be provided substantially parallel to the transportation path of the electric wire. The tubular member only needs to be tubular while the ink of the printed image is dried, and may be of another shape in any other step. For example, the tubular member may include a movable portion, so that the shape thereof is changeable.

The electric wire printing device does not need to include a tubular member such as the guide pipe **50**. FIG. **7** is a schematic view showing a configuration of an electric wire printing device **10** according to another embodiment. In the following description of the embodiment, elements having the same functions as those in the above-described embodiment will bear the same reference signs as in the above-described embodiment. As shown in FIG. **7**, the electric wire printing device **10** according to this embodiment includes the inkjet head **30** injecting ink to perform printing on the electric wire **5**, a transportation device **20** transporting the electric wire **5** at least after the inkjet head **30** performs printing on the electric wire **5**, and a drying device **40** not including the tubular member. Like in the above-described embodiment, the driving device **40** is provided downstream, in the transportation direction of the electric wire **5**, with respect to the inkjet head **30**. The drying device **40** according to this embodiment includes an air nozzle **41** blowing air toward a printed portion on the electric wire **5**. The air nozzle **41** is connected with the air compressor **80** external to the printing device **10** via the air flow path **62**. The open/close valve **63**, the decompression valve **64**, the flow rate adjusting valve **65** and the heater **66** are provided on the air flow path **62**. In this embodiment, the air is blown toward the printed image **7** on the electric wire **5** directly from the air nozzle **41**.

As shown in FIG. **7**, in this embodiment, the drying device **40** blows the air upstream in the transportation direction of the electric wire **5**. Like in the above-described embodiment, the transportation device **40** transports the electric wire **5** while the drying device **40** is blowing the air toward the printed portion on the electric wire **5**. As a result, the speed of the flow W of the air with respect to the electric wire **5** is increased. Note that the drying device **40** does not need to blow the air upstream in the transportation direction of the electric wire **5**. For example, the drying device **40** may blow the air in a direction perpendicular to the transportation direction of the electric wire **5**. In this specification, the expression "blow the air in a direction" encompasses, in a broad sense, generating a flow of the air directed in a predetermined direction by the configuration of a flow path as in, for example, the above-described embodiment.

In the embodiment described with reference to FIG. **7** also, the ink of the printed image **7** is dried in a shorter time than by natural drying. There is no specific limitation on the number of the air nozzle(s) **41**, and there may be a plurality of air nozzles **41**. The air to be blown toward the printed image **7** on the electric wire **5** does not need to be compressed air generated by an air compressor or the like. The drying device **40** may include, for example, a blower fan that blows air toward the printed image **7** on the electric wire **5**.

The embodiments do not limit the present invention unless otherwise specified.

## REFERENCE SIGNS LIST

**5** Electric wire
**7** Printed image
**10** Electric wire printing device
**20** Transportation device
**30** Inkjet head
**40** Drying device
**50** Guide pipe (tubular member)
**51** Insertion hole
**51***d* Entrance opening (opening)
**51***e* Electric wire exit
**52** Air supply inlet (supply inlet)

The invention claimed is:

**1**. An electric wire printing device, comprising:

an inkjet head injecting ink to perform printing on an electric wire;

a transportation device transporting the electric wire; and

a drying device provided downstream, in a transportation direction of the electric wire, with respect to the inkjet head, the drying device blowing air toward a printed portion on the electric wire; wherein

the transportation device transports the electric wire in a longitudinal direction of the electric wire;

the drying device includes a tubular member provided so as to surround a transportation path of the electric wire;

an inner space is provided in the tubular member through which the electric wire is to pass; and

the tubular member includes:

a large area portion demarcating an upstream portion of the inner space in the transportation direction of the electric wire and including an entrance opening through which the electric wire is inserted, the entrance opening being provided at an upstream end of the upstream portion;

a small area portion demarcating a downstream portion of the inner space in the transportation direction of the electric wire and including an electric wire exit through which the electric wire exits, the electric wire exit being provided at a downstream end of the downstream portion and having an opening area that is smaller than an opening area of the entrance opening;

a tapering portion demarcating an intermediate portion of the inner space between the large area portion and the small area portion and having a tapering shape which has a cross-sectional area decreasing toward the small area portion; and

a supply inlet opens toward the large area portion to allow compressed air to be supplied therethrough.

**2**. The electric wire printing device according to claim **1**, wherein:

the transportation device transports the electric wire while the compressed air is supplied from the supply inlet.

**3**. The electric wire printing device according to claim **1**, wherein the supply inlet runs through the tubular member in a direction crossing the longitudinal direction of the electric wire.

**4**. The electric wire printing device according to claim **3**, wherein the supply inlet is provided so as to be shifted with respect to the transportation path of the electric wire as seen in a direction in which the supply inlet runs through the tubular member.

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